

## CLAIMS:

1. A method of operating a DC/DC up-down converter which has
- an input voltage ( $U_{in}$ ) and at least a first and a second output voltage ( $U_A$ ,  $U_B$ ),
  - at least one inductive energy storage means ( $L_1$ ), which is connected with a first terminal ( $X_1$ ) to a main switching means ( $T_1$ ) and can be connected with a second terminal ( $Y_1$ ) to at least two outputs (A B) via switching means ( $T_3$ ,  $D_3$ ),
  - output switching means ( $T_3$ ,  $D_3$ ) for providing electrical energy for the first and second output voltages ( $U_A$ ,  $U_B$ ) by supplying a coil current ( $I_{L1}$ ),
  - a main switching means ( $T_1$ ) between the inductive energy storage means ( $L_1$ ) and a DC voltage source generating the input voltage ( $U_{in}$ ),
  - a free-wheeling switching means ( $T_2$   $D_2$ ) which makes possible the continuation of the current flow in the inductive means ( $L_1$ ) if the main switching means ( $T_1$ ) is switched off and
  - a control means (controller) for selective actuation of all switching means ( $T_1$ ,  $T_2$ ,  $T_3$ ,  $T_4$ ),

wherein

- the first output voltage ( $U_A$ ), which is lower than the input voltage ( $U_{in}$ ), is present on the first output (A) and
- the second output voltage ( $U_B$ ), which is higher than the input voltage ( $U_{in}$ ), is present on the second output (B)
- at least a further switching means ( $T_3$ ) for controlling the direction of the coil current ( $I_{L1}$ ) into the first output (A) or into the second output (B) is connected in series with the first output (A),

characterized in that the control means (controller)

-- controls the output switching means ( $T_3$ ,  $T_4$ ), so that in the course of one switching cycle ( $SZ_1$ ,  $SZ_2$ ) the coil current ( $I_{L1}$ ) flows from the second terminal ( $Y_1$ ) into both output branches (A, B) and

-- controls the main switch ( $T_1$ ) in the transient state of the up-down converter, so that  
 5 the average voltage on the first terminal ( $X_1$ ) is equal to the voltage on the second terminal ( $Y_1$ ).

2. A method as claimed in claim 1 in which the control means (controller) generates switching phases ( $\Phi_2$ ,  $\Phi_3$  and  $\Phi_5$ ,  $\Phi_6$ , respectively) for the switching means  
 10 ( $T_1$ ,  $T_2$ ,  $T_3$ ,  $T_4$ ) and the course of the coil current ( $I_{L1}$ ) comprises an up-conversion phase and a down-conversion phase, characterized in that the down-conversion phase of the coil current ( $I_{L1}$ ) comprises at least two switching phases ( $\Phi_2$ ,  $\Phi_3$  and  $\Phi_5$ ,  $\Phi_6$ , respectively).

15 3. A method as claimed in claim 2, characterized in that the switching cycle ( $SZ_1$ ,  $SZ_2$ ) has all the switching phases ( $\Phi_1$ ,  $\Phi_2$ ,  $\Phi_3$  and  $\Phi_4$ ,  $\Phi_5$ ,  $\Phi_6$ , respectively), exactly once.

4. A method of operating a DC/DC up-down converter which has  
 20 - an input voltage ( $U_{in}$ ) and at least a first and a second output voltage ( $U_D$ ,  $U_E$ ),  
 - at least one inductive energy storage means ( $L_2$ ), which is connected with a first terminal ( $X_2$ ) to a DC voltage source generating in the input voltage ( $U_{in}$ ) and can be connected with a second terminal ( $Y_2$ ) to the outputs (D, E) via the switching means ( $T_6$ ,  $D_4$ ),  
 25 - output switching means  $T_6$ ,  $D_4$ ) for providing electrical energy for the first and the second output voltage ( $U_D$ ,  $U_E$ ) by supplying a coil current ( $I_{L2}$ ),  
 - a main switching means ( $T_5$ ) between a second terminal ( $Y_2$ ) of the inductive energy storage means ( $L_2$ ) and the other pole of the DC voltage source, and  
 - a control means (controller) for selectively actuating all switching means ( $T_5$ ,  
 30  $T_6$ ,  $T_7$ ),

wherein

- the first output voltage ( $U_D$ ), which is lower than the input voltage ( $U_{in}$ ), is present on the first output (D) and
- the second output voltage ( $U_E$ ), which exceeds the input voltage ( $U_{in}$ ), is present on the second output (E),
- at least a further switching means ( $T_6$ ) for controlling the direction of the coil current ( $I_{L2}$ ) into the first output (D) or into the second output (E) is connected in series with the first output (D),

characterized in that the control means (controller)

- controls the output switching means ( $T_6$ ,  $T_7$ ), so that in the course of one switching cycle ( $SZ_3$ ,  $SZ_4$ ) the coil current ( $I_{L2}$ ) flows from the second terminal ( $Y_2$ ) into both output branches (D, E, F) at least once and and
- controls the main switch ( $T_5$ ) in the transient state of the up-down converter so that the average voltage on the second terminal ( $Y_2$ ) of the coil ( $L_2$ ) is equal to the voltage on the first terminal ( $X_1$ ), thus equal to the input voltage ( $U_{in}$ ).

5. A method as claimed in claim 4, wherein the control means (controller) generates switching phases ( $\Phi_7$ ,  $\Phi_8$ ,  $\Phi_9$  and  $\Phi_{10}$ ,  $\Phi_{11}$ ,  $\Phi_{12}$ ,  $\Phi_{13}$  respectively) for each switching means ( $T_5$ ,  $T_6$ ,  $T_7$ ) and the pattern of the coil current ( $I_{L2}$ ) has an up-conversion phase and a down-conversion phase, characterized in that the up-conversion phase of the coil current ( $I_{L2}$ ) comprises at least two switching phases ( $\Phi_7$ ,  $\Phi_8$  and  $\Phi_{10}$ ,  $\Phi_{11}$  respectively).

6. A method as claimed in claim 5, characterized in that the switching cycle ( $SZ_3$ ,  $SZ_4$ ) comprises all switching phases ( $\Phi_7$ ,  $\Phi_8$ ,  $\Phi_9$  and  $\Phi_{10}$ ,  $\Phi_{11}$ ,  $\Phi_{12}$ ,  $\Phi_{13}$ , respectively), exactly once.

7. A method as claimed on one of the preceding claims, characterized in that the switching means ( $T_1$ ,  $T_2$ , ...,  $T_7$ ) are MOSFETs, IGBTs, GTOs or bipolar transistors.

8. Implementation of a method as defined in the Claims 1 to 9, for the operation of a DC/DC up-down converter in electronic appliances in which consumers are to be supplied with different voltages such as, for example, in mobile telephones, PDAs
- 5 (Personal Digital Assistants) or MP3 players.